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TWO NEW CYSTOCERCOUS CERCARIAE FROM NORTH AMERICA*

Ernest Carroll Faust

Following the description of the unique anchor-tailed *Cercaria mirabilis* by Braun (1891), Ward (1916) published an account of two similar American cystocercous species, *Cercaria wrightii* and *C. anchoroides*. The former of these American species had been previously mentioned by Wright (1885) and Leuckart (1886). Knowledge of the structure and relationship of this group is further augmented by the study of two new American species, for which the names *Cercaria brookoveri* and *C. macrostoma* are proposed.

Cercaria brookoveri nov. spec.

This interesting cystocercous cercaria was obtained by Professor Chas. Brookover from Campeloma sp. at Cedar Point, Lake Erie, April 23, 1912. The writer has been enabled to examine it thru the kindness of Professor Henry B. Ward. The worm consists of a body of typical distome characters, 0.52 to 0.62 mm. long and 0.3 to 0.37 mm. wide, a large sac-like tail trunk 1.37 mm. long and 0.46 mm. in diameter, and a pair of bluntly pointed anchor-flaps 0.45 mm. long and 0.35 mm. wide. The distome is not included within the anterior region of the tail trunk as in the previously described cercariae of this type (*C. mirabilis, C. wrightii, C. anchoroides*), but is attached at its posterior end to the trunk by a stipe, and surrounded for a short distance by a collar extension of the trunk. A cross section of the tail trunk is circular with a large central lumen, the caudal excretory trunk, while a matrix of loosely woven parenchyma cells fills the interstices between lumen and ectoderm. The excretory tube divides anterior to the anchor flaps, one branch entering each flap.

The distome is round to oval in cross section. The oral sucker, 40 by 38μ, is directed ventrad. The acetabulum, 41 by 32μ, is slightly anterior to the middle of the body. Above the oral sucker and slightly caudad is the pharynx, 21μ in diameter. It leads into the intestinal ceca thru a very short esophagus. The diverticula extend laterad, then caudad, toward the posterior margin of the worm. They are somewhat convoluted and are filled with a semi-transparent jelly mass, which includes many small refractive granules and vacuoles. The walls of the diverticula consist of flat polygonal cells, scarcely differentiated from the body parenchyma. The excretory bladder is posterior. From it a large median tube leads forward toward the acetabulum. Its further course has not been observed. The reproductive organs are represented by a large oval cell mass posterior to the acetabulum, an elongate mass under the anterior wall of the acetabulum and a chord connecting these two masses around the right wall of the acetabulum. A comparison of size measurements of *C. brookoveri* and *C. anchoroides* seems to indicate that the two species are distinct (see table).

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The nervous system is plainly detailed in frontal sections of the cercaria. There is a small cerebral ganglion mass and a subesophageal commissure almost as large. The ventrales and dorsales are easily found. Posterior to the brain the ventrales are the most conspicuous. From the subesophageal commissure two pharyngeales with intercommunicating network are derived. Along the ventral trunks the preacetabular and postacetabular commissure are prominent. There are many ventral commissures.

Like *Cercaria mirabilis* (Braun 1891) this cercaria develops within a sporocyst. The sporocyst of *C. brookoveri* reaches a length of 2.6 mm. and a cross diameter of 0.9 mm. Within it are all stages of developing cercariae from germ ball to mature larva, but only one individual of each stage is found at any one time (Figs. 2, 3, 5). The sporocyst is elongate to oval and has many prominent muscular annuli around its outer girth. As the cercaria develops the distome body is at first largest and most distinctive, with only a suggestion of the anchor flaps (Fig. 3). Later, however, the tail trunk elongates and the junction of body and tail becomes more differentiated by the formation of a stipe connection and a partial enveloping of the posterior part of the worm with the anterior part of the tail trunk. The mature larva differs from this stage in the amplification of the main trunk of the tail and the differentiation of the anchor flaps.

There is evidence to show that *C. brookoveri* is cannibalistic. Within a sporocyst of this species the larger and more mature larvae with their powerful suckers secure a hold on the less mature individuals and, with the aid of secretory juices, digest them bit by bit (Fig. 6). Thus it is probable that many germ balls are produced which never are allowed to mature because they are ingested by their more hardy congeners.

Cercaria macrostoma nov. spec.

A single specimen of this larva for which the name *Cercaria macrostoma* is proposed was found in an aquarium in the Zoological Laboratory of the University of Illinois in October, 1917. The writer desires to thank Mr. E. C. Harrah for the specimen. The aquarium had been used for a week to contain several specimens of *Campeloma subsolidum* (Anthony) and *Goniobasis pulchella* (Anthony) before the fluke was discovered. The size of the larva and the paddle movement of the tail flaps, together with the creamy yellow color of the whole body, made the worm a conspicuous object. The movement was similar to that described by Ward (1916) for *C. anchoroides*. At first only the superficial features of the larva were evident, but under pressure of the cover slip the internal characters became clear. The trunk is a thick, oblong object, slightly conical anteriad and wedge-shaped posteriad. The flappers are broadly spatulate. At times they are found at right angles to the trunk, at other times they approximate one another as the wings of a butterfly. At the anterior end of the trunk there is a central median evertible proboscis surrounded by a ring of five large wartose papillae. Two of these are ventral, two lateral, and one median dorsal. Spread over the anterior two-thirds of the trunk are irregular rings of warts somewhat smaller than those around the anterior end. The larval distome is found within the anterior two-fifths of the enveloping trunk.

Cercaria macrostoma has a measurement of 5.0 mm. for the caudal trunk length and a cross diameter of 1.1 mm. Thus it exceeds *C. wrightii*, *C. anchoroides* and *C. brookoveri* in size and approximates *C. mirabilis* (Braun 1891). The flappers are 1.2 mm. long and 0.83 wide. The distome itself measures 1.2 mm. in length by 0.5 mm. in width. It is broadest near the posterior end.

The oral sucker of the larval distome is large, measuring 0.48 by 0.36 mm. in diameter, while the acetabulum is 0.20 mm. wide and 0.26 mm. long. The latter is situated somewhat posterior to the middle of the body. The oral sucker leads into a pharynx 70μ in diameter. The esophagus is very short. The ceca first run dorsad then laterad, and then continue posteriad to the caudal region of the body. Here they curve inward and almost meet in the region ventral to the excretory bladder. They are coiled thruout their entire length. They are filled with a semitransparent yellow jelly mass in which are imbedded refractive granules. The excretory system is constructed on the plan of a long slender Y, with a slightly dilated base. The fork occurs just dorsal to the acetabulum. One pair of fine capillaries extends inward in the region of the pharynx, but the main tubule extends forward on each side around the oral sucker.

The reproductive organs are well developed, constituting a precocious condition (Fig. 7). A pair of testes and an ovary are found behind the acetabulum. In front of the acetabulum is a large cirrus pouch with thick cuticular walls and further dorsad is a large seminal vesicle. A uterus filled with rips eggs is found to arise in the region of the ovary, and, after coiling a short distance backward, is seen to turn to the right of the acetabulum and run to the region of the pharynx, and thence to the genital pore. The eggs measure 78 to 88μ in length by 47 to 50μ in cross diameter. The vitelline follicles are arranged in two loosely strung chords at the sides of the body. They extend from the region of the pharynx to the posterior region of the body. This fluke is probably an Allocreadiine species.

TABLE OF COMPARATIVE DATA ON CYSTOCERCOUS CERCARIAE

	C. mirabilis Braun	*C. wrightii* Ward	*C. anchoroides* Ward	*C. brookoveri* Faust	*C. macrostoma* Faust
Found	Free, aquarium	Free. aquarium	Free, Lake St. Clair	In snail	Free, aquarium
Place	Kurland	Toronto, Can.		Sandusky, O.	Urbana, Ill.
Date	1891	1885	1893	1912	1917
Larval host..	*Lymnaea palustris corvus*	Unknown	Unknown	Campeloma sp.	Unknown
Parthenita ...	Sporocyst	....	....	Sporocyst	....
Size Distome					
Length	....	0.45 mm.	0.64 mm.	0.52-0.62 mm.	1.2 mm.
Width	....	0.1 mm.	0.288 mm.	0.3-0.37 mm.	0.5 mm.
Tail					
Length	6.0 mm.	1.0 mm.	2.0 mm.	1.37 mm.	5.0 mm.
Width	....	0.133 mm.	0.28 mm.	0.46 mm.	1.1 mm.
Flappers					
Length	1.5 mm.	0.533 mm.	0.53-0.6 mm.	0.45 mm.	1.2 mm.
Width	....	0.1 mm.	0.24-0.34 mm.	0.35 mm.	0.83 mm.
Suckers					
Oral	....	41μ	160μ	40x38μ	480x360μ
Ventral ...	Larger than oral	75μ	128-144μ	41x32μ	200x260μ
Digestive System					
Ceca	....	....	Large, heavy	Large	Crowded, especially in posterior end
Pharynx					
Diameter ..	....	....	64μ	21μ	70μ
Excretory System ..	....	....	Reservoir reaches acetabulum	Reservoir ends little posterior to acetabulum	Reservoir continues anterior to acetabulum

GENERAL CONSIDERATIONS

Aside from their anchor tail the species of this group possess other characters in common which demonstrate their close relationship. Among these are the crowded ceca with granular contents, the long median Y-shaped excretory bladder, the presence of the ovary and pair of testes close behind the acetabulum, and the swollen cirrus pouch anterior to the acetabulum. It seems significant, likewise, that Braun (1891) and Ward (1916) found wart-like protuberances on the external surfaces of the trunk, similar to those recorded for *C. macrostoma.* These species differ from *Cercaria macrocerca* de Filippi in possessing no stylet. The latter species also has no anchor flaps to the tail.

On account of the fundamental agreement of the five described species of this group, the common history of all may be learned by coordinating data from the several species. In general, the cercariae develop as the parthenogenetic offspring of sporocysts. They are found in the respiratory or digestive organs of snails. In the differentiation of the germ balls the suckers first become set off from the body, then the caudal organ is outlined. The anchor flaps first show as stubs. Somewhat later the region between body and tail becomes differentiated into a central stipe and an outer enveloping collar. In *C. brookoveri,* perhaps the least modified of all the described species, the collar is only a partial envelop. In the other four species, however, this portion of the trunk comes to surround the worm entirely save for a pore at the anterior end of the animal. Further differentiation consists in the formation of warts at various places, but most prominently around the anterior end of the worm. In *C. macrostoma* there are, in addition to the ordinary warts, five prominent papillae around the oral opening of the cyst. Ward (1916: 16) has noted that the movement of the worm is the reverse of that usually found in other groups of cercariae.

While the digestive and excretory organs are equally developed in all of the species, the genital system in *C. macrostoma* alone are sufficiently mature to warrant a suggestion of the systematic position of the group. These quite definitely relate the group to the Allocreadiidae. The limited extent of the uterus excludes these species from the Bunoderinae. The papillae on the outer surface of the worms are structurally similar to those in the Stephanophialinae, but are located on the modified portion of the tail rather than on the body of the flukes, hence are not to be considered as homologous to the oral papillae of the Stephanophialinae. The only Allocread species, the life history of which is known, is *Allocreadium isoporum* Looss. The larva of this species has a rhopalocercous structure, which is somewhat simpler than that of *C. brookoveri.* When all of the group characters are considered it seems highly probable that these five species represent a portion of the Allocreadiinae, for which there is as yet no satisfactory classification.

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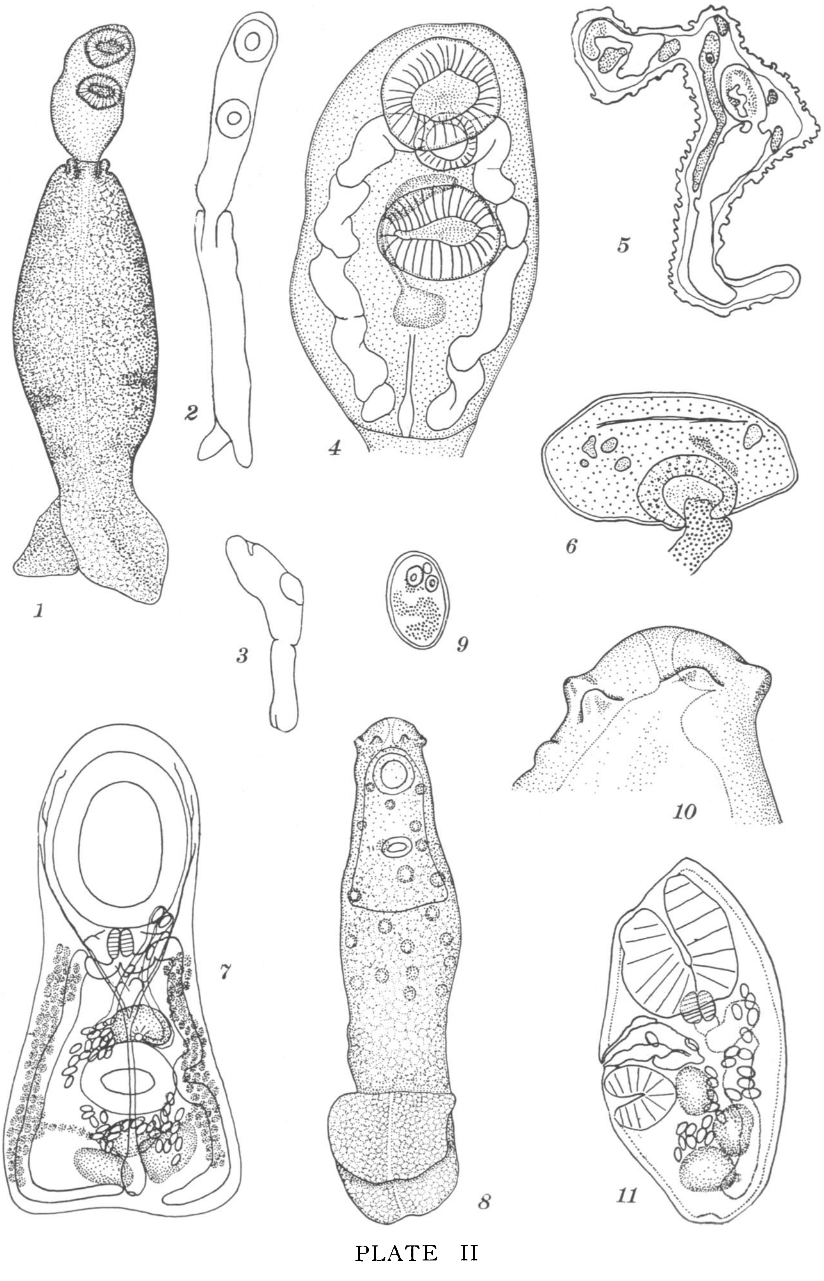

PLATE II

EXPLANATION OF PLATE

Cercaria brookoveri. 1. Sketch of entire cercaria, ventral view, × 34. 2, 3. Stages in the development of the cercaria, × 54. 4. Body of the worm enlarged, ventral view, × 105. 5. Section of sporocyst with developing cercariae, × 34. 6. Section of a maturing individual ingesting a younger individual, × 75.

Cercaria macrostoma. 7. Ventral view of living fluke compressed, showing important details of digestive, excretory and genital systems, × 54. 8. Sketch of entire cercaria, ventral view, × 14. 9. Uterine egg, × 170. 10. Detail of anterior end of cyst, showing papillae, lateral view, ×26. 11. Lateral view of preserved fluke, × 34.